

## Surface Circulation in the Northeastern Mediterranean (NEMED)

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Award #: N000140810945

[http://poseidon.ogs.trieste.it/sire/drifter/nemed\\_main.html](http://poseidon.ogs.trieste.it/sire/drifter/nemed_main.html)

### LONG-TERM GOALS

To investigate the dynamics of semi-enclosed seas dominated by buoyancy input and wind forcing, and influenced by complex topography. To improve the understanding of coastal marine environmental evolution, with particular emphasis on eddy dynamics.

### OBJECTIVES

The main goal on the NEMED project is to measure the surface currents in the Eastern Mediterranean Sea with particular focus to the eastern and northern areas of the Levantine sub-basin and to validate (or not) circulation patterns published in the literature based on in-situ observations (CTD and AXBT), remote sensing data (SST and sea surface topography) and models. It is proposed to use low-cost satellite-tracked drifters to measure currents in the near-surface mixed-layer. The monitoring of the circulation in the Northeastern Mediterranean, with main focus on the currents trapped on the topographic slope and on sub-basin and mesoscale eddies, is planned for a full year in order to investigate any seasonal variability. The surface current observations will be interpreted in concert with the distribution of tracers (SST, chlorophyll, etc.) measured from satellites.

### APPROACH

The following tasks will be performed:

- Literature review of the Levantine Sea oceanography.
- Procurement and deployment of SVP (GDP) drifters with Argos data telemetry and positioning. Seasonal deployments of drifters are planned starting in summer 2009 in three geographical areas: south of Cyprus, east of Israel and south of the Turkey with the help of local oceanographers.
- Drifter data management in both near-real time (processing and posting on the web) and delayed-mode (creation of a database updated every three months). Acquisition of satellites images for the Northeastern Mediterranean (SST and ocean color).

<b>Report Documentation Page</b>			<i>Form Approved OMB No. 0704-0188</i>	
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1. REPORT DATE <b>2009</b>	2. REPORT TYPE	3. DATES COVERED <b>00-00-2009 to 00-00-2009</b>		
4. TITLE AND SUBTITLE  <b>Surface Circulation in the Northeastern Mediterranean (NEMED)</b>			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Borgo Grotta Gigante, 42/c, 34010 Sgonico (Trieste), Italy,</b>			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>				
13. SUPPLEMENTARY NOTES				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>4</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>	19a. NAME OF RESPONSIBLE PERSON	

- Statistical analyses using the drifter velocity data: mean circulation and eddy variability maps for the different seasons and wind regimes, Lagrangian statistics (integral time and length scales and eddy diffusivities). Qualitative description of the circulation using drifter and satellite data (creation of images and animations with color-coded SST/chlorophyll fields overlaid with drifter tracks).

## WORK COMPLETED

SVP drifters were purchased and shipped to our collaborators in Cyprus, Israel and Turkey. The P.I. visited the Israel Oceanographic and Limnological Research (IOLR) Institute in Haifa, Israel in May 2009 to discuss deployment plans in the coastal waters of Israel.

The first cluster of 3 drifters was deployed on 29 July 2009 off the city of Ashdod, between 9 and 12 nm from the coast, by our Israeli collaborators (See Table 1). A few days later, on 3 August 2009, 3 units were deployed from the ferry connecting Limassol (Cyprus) to Port Said (Egypt) by our collaborators from Cyprus. As of 14 October 2009, 4 drifters are still operational in the Levantine Sea, and two units have stranded or were picked up (drifter a92062 on the northern Lebanon coast in late August 2009 and drifter a92064 near the southern Turkish coast on 12 September 2009, see Figure 1).

Unfortunately, the deployments planned south of Mersin (Turkey) have not commenced because the drifters have been seized by the Turkish Customs authorities in Istanbul. We hope that they will be released and be deployed in the Cilician sub-basin in late 2009 or early 2010. The next drifter deployments south of Cyprus and west of Israel are planned in November-December 2009. These deployments will be conducted by our collaborators and also as part of the TARA Oceans Expedition.

The NEMED web pages were created. They provide basic information on the project, near real time (updated on a daily basis) products such as graphs with drifter trajectories and with time series of position (latitude and longitude, speed, sea surface temperature, battery voltage, drogue presence parameter, etc.). A status table (Table 1) is also included to monitor the drifter array. The drifter positions have also been implemented in Google Earth (see Figure 1). The URL address of the NEMED main page is: [http://doga.ogs.trieste.it/sire/drifter/nemed/nemed\\_main.html](http://doga.ogs.trieste.it/sire/drifter/nemed/nemed_main.html)

## RESULTS

The drifter put in evidence a strong coastal current flowing northward along the coasts of Israel, Lebanon and Syria. This current can create instability features shown as loops in the drifter trajectories (Figure 1). In particular, all the drifters deployed off Israel were deviated offshore and got trapped in an anticyclonic eddy northwest of Haifa. Presumably, this circulation feature moved subsequently to the northwest and entrapped 2 drifters as long as more than a month. The diameter of this eddy is about 50 km, the period of rotation is about 6 days and typical speeds are 50 cm/s.

Another interesting aspect of the drifter trajectories is depicted by the drifter deployed close to the southern coast of Cyprus. This drifter moved initially to the east and joined the northward flow off Lebanon. It then re-circulated in the area between Cyprus and the coast of Lebanon and Syria. It almost entered the Cilician sub-basin northwest of Cyprus but finally moved back towards the south offshore of southern Turkey and Syria.

**Table 1. Status table for the drifters deployed in the Eastern Levantine Sea in July/august 2009 as it appeared on the NEMED web pages on 14 October 2009.**

<b>Status Table</b>										
Institute	WMO	Argos	Deploy Date	Lat	Lon	Last Date	Lat	Lon	Status	
OGS	61964	a92062	29/07/09 09:00	31.888	34.478	03/10/09 07:50	34.569	35.992	●	
OGS	61965	a92063	29/07/09 09:28	31.903	34.417	13/10/09 23:18	33.387	32.503	●	
OGS	61966	a92064	29/07/09 09:59	31.924	34.348	12/09/09 03:55	36.016	35.963	●	
OGS	61959	a92057	03/08/09 13:28	34.415	33.027	13/10/09 23:18	35.208	35.219	●	
OGS	61960	a92058	03/08/09 21:05	32.59	32.627	13/10/09 23:18	32.111	33.345	●	
OGS	61963	a92061	03/08/09 17:18	33.498	32.82	13/10/09 23:20	31.586	32.573	●	

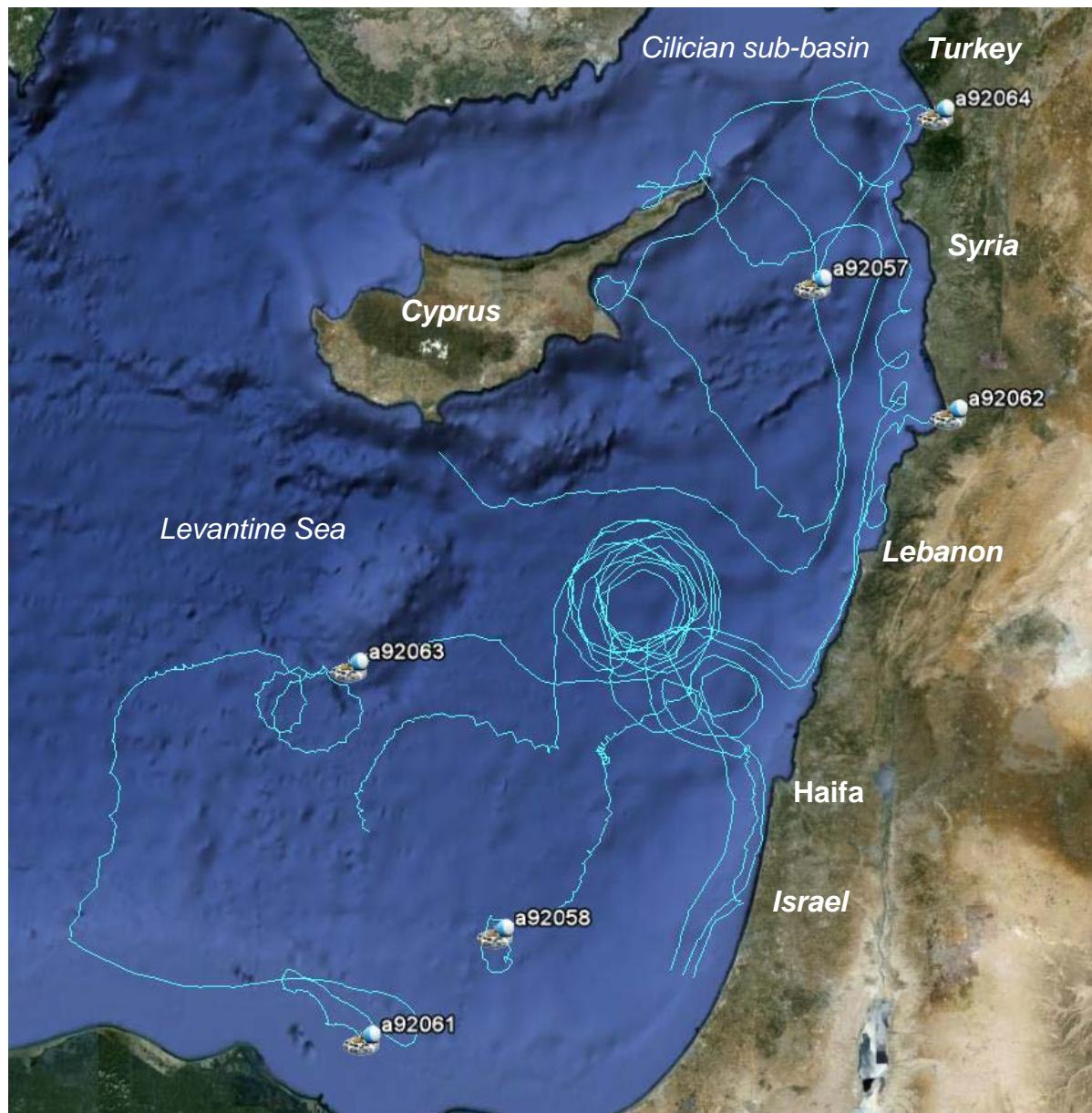
●: dead      ●: working without position      ●: alive      ●: stranded

## IMPACT/APPLICATION

The scientific impact of this project is to increase our understanding of the Northeastern Mediterranean Sea dynamics and of its major forcing mechanisms. Future application could be the validation of diagnostic numerical models and the assimilation of the drifter data into prognostic numerical models in the framework of operational oceanography projects (e.g., as part of the Mediterranean Operational Oceanography Network – MOON).

## RELATED PROJECTS

In addition to national programs conducted by collaborators in Cyprus, Israel and Turkey, the NEMED project is strongly related to MOON (<http://www.moon-oceanforecasting.eu/>), both in terms of observational activities, such as the Mediterranean Volunteer Observing Ship program (VOS) and the Mediterranean Argo program (MedArgo; coordinated by the P.I., <http://poseidon.ogs.istrieste.it/sire/medargo/>) and nowcasting and forecasting numerical simulations. It is also related to the French project to study the entrapped ecosystem related to the Shikmona or Cyprus eddy as part of the TARA Oceans Expedition (<http://oceans.taraexpeditions.org/>).



*Figure 1. Trajectories of the surface drifters in the eastern Levantine sub-basin. Drifter identification numbers are posted at the end of the tracks and indicate the drifter positions on 13 October 2009.*